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February 20, 1992

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Board of Standards Review
American National Standards Institute
11 West 42nd Street
New York, New York 10036

Re: Comments on Proposed BSR/IEEE C95.1-1990 Draft Standard, Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz (revision of ANSI C95.1-1982).

Dear Sir or Madam:

This letter is being submitted in response to the December 27, 1991, *ANSI Standards Action* newsletter requesting comments from interested parties on various proposed standards. The newsletter indicates that the deadline for comments on the above referenced proposed standard is February 25, 1992, so this letter is timely filed.

We feel the proposed standard has some serious shortcomings. It is our hope that these comments will result in ANSI not adopting the proposed standard, and instead remanding the proposed standard back to the IEEE SCC28 committee for further work.

First, some background on Hammett & Edison and our qualifications, as it were, to make comments on the proposed C95.1-1990 Standard. Hammett & Edison, Inc., Consulting Engineers, is a professional service corporation that provides consultation to commercial and governmental clients on communications, radio, television, and related engineering projects. The technical staff is comprised of nine engineers, which is supported by drafting, secretarial, and accounting personnel. Specialized computer, instrumentation, and laboratory facilities are provided as required by the projects undertaken.

We have been very active in the field of radio frequency radiation ("RFR") measurements, particularly as they apply to broadcast stations. We provided input to the FCC when it was preparing its Office of Science and Technology Bulletin No. 65, "Evaluating Compliance with FCC-Specified Guidelines for Human Exposure to Radio Frequency Radiation" ("OST65"), and we were responsible for a new categorical exclusion being adopted by the FCC for stations that do not by themselves exceed 1% of the ANSI C95.1-1982 Standard (FCC General Docket 88-469, effective April 18, 1990). We have performed RFR surveys or calculations at numerous broadcast sites, such as the Sutro Tower in San Francisco, the San Bruno Mountain antenna farm south of San Francisco, the Mt. Wilson antenna farm near Los Angeles, the Walnut Grove antenna farm near Sacramento, South Mountain Park antenna farm near Phoenix, Farnsworth Peak

near Salt Lake City, Mt. Soledad in San Diego, and the Senior Road antenna farm near Houston, to name just a few.

William F. Hammett, P.E., of our firm has co-authored the chapter on RFR compliance for the upcoming Eighth Edition of the National Association of Broadcasters ("NAB") Engineering Handbook. The other co-authors are Jules Cohen, P.E., and Richard A. Tell, both members of the IEEE SCC28 Committee (formerly the ANSI C95 Committee). I have appeared on several national RFR workshop panels sponsored by the NAB and by the Society of Broadcast Engineers ("SBE"), and my name appears on page (i) of the OST65 ("Acknowledgements"). We therefore have considerable experience in RFR issues and great interest in any changes to the current ANSI C95.1-1982 RFR standard.

Our biggest concern with the IEEE C95.1-1990 draft standard is its adoption of a "body current" limit for conducted radio frequency currents. We feel that measurements of body currents will depend so heavily on variations among different human bodies that it cannot be a practical criteria in the real world. For example, Section 4.1.1(a)(i) of the proposed standard would create a limit of 100 mA of induced body current through each foot of a freestanding individual. Is this with or without shoes and socks? Dry or sweaty feet? Leather soles or rubber soles? For a 72-inch adult male or a 36-inch toddler? A workable RFR standard should prescribe acceptable limits on the environment and not an infinite number of possible individual responses to that environment. We need to be able to make objective, not subjective, measurements. Ambient fields should tell the whole story for compliance certification purposes.

A second major problem with the draft standard is its use of arbitrary breakpoints in frequency for changes in exposure limits. The predominant sources of RF radiation will be, by law, radio and television stations. In the absence of experimental data, or any suitable hypothesis, of sharp frequency-dependence, the arbitrary selection of breakpoints to assign different exposure limits for stations *in the same band* is not justifiable and, further, does a disservice to the industry. For instance, instead of a breakpoint at 100 MHz, right in the middle of the 88–108 MHz FM band, why not use 88 MHz, so that all FM stations are treated uniformly? Or, even better, why not use 54 MHz, so that all VHF TV stations are also treated uniformly? Also, with regard to the MPE for uncontrolled environments, why introduce an arbitrary breakpoint at 1.34 MHz, right in the middle of the 0.54–1.70 AM band? And finally, for the maximum permissible exposure on contact currents (should this ill-defined aspect actually be included in the final standard), why stop at 100 MHz? There is no basis for establishing an exposure limit applicable to an FM station operating on 99.9 MHz, for example, while exempting the adjacent-channel FM station operating on 100.1 MHz. Here again, 54 MHz would be the better choice for an upper limit (or perhaps 50 MHz, if round numbers are more appealing).

The key issue for our broadcast clients is meeting FCC-specified RFR criteria. As you undoubtedly know, the FCC selected the non-governmental ANSI C95.1-1982 guidelines because they are scientifically based, widely accepted, and applicable to the general population as well as to workers. When the successor to ANSI C95.1-1982 is officially adopted by ANSI, the FCC will then open a rule-making proceeding to decide whether to

Board of Standards Review, page 3
February 20, 1992

adopt that new guideline. The FCC may well choose another guideline if the new ANSI standard adopts impractical body current criteria which will vary with the size, mass, clothing, and skin conditions of persons subjected to electromagnetic fields, or if radio or television stations within the same bands are treated differently.

We therefore urge ANSI not to adopt the proposed IEEE C95.1-1990 standard in its current form.

Sincerely,

Dane E. Ericksen

lr

cc: Ms. Linda A. Dame, IEEE
Dr. Robert F. Cleveland, Jr., FCC
Mr. Jules Cohen, P.E., Jules Cohen & Associates, P.C.
Mr. Richard A. Tell, Richard Tell Associates, Inc.



IEEE STANDARDS DEPARTMENT

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445 HOES LANE, P.O. BOX 1331, PISCATAWAY, NJ 08855-1331, U.S.A. TELEX 833233, FAX (908) 562-1571

April 6, 1992

Dane E. Ericksen
Hammett & Edison, Inc.
Box 280068
San Francisco, CA 91428-0068

Dear Mr. Ericksen:

Enclosed is the SCC28 rebuttal submitted in response to the concerns expressed in your letter of February 20, 1992.

If I do not hear from you on or before April 20, I will assume your questions have been answered.

Very truly yours,

Linda A. Gargiulo
Linda A. Gargiulo
Administrative Assistant

enclosure

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Raytheon Company
(617) 860-3041

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Safety Levels With Respect to
Human Exposure, 0-3 kHz
Dr. John A. Bergeron
G.E. Corp. Research & Development
(518) 387-6350

Mr. William Feero
Electric Research and Management, Inc.
(814) 466-3031

SC-4

Safety Levels With Respect to
Human Exposure, 3kHz-300GHz
Dr. Eleanor R. Adair
J. B. Pierce Foundation Labs
(203) 562-9901; Ext. 218

Dr. Om P. Gandhi
University of Utah
(801) 581-7743

SC-5

Safety Levels
With Respect to Electro-Explosive
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PLEASE REPLY TO:

Dr. Om P. Gandhi
Department of Electrical
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3280 MEB
University of Utah
Salt Lake City, Utah 84112

Ms. Linda A. Gargiulo
IEEE Standards Department
445 Hoes Lane
PO Box 1331
Piscataway, NJ 08855-1331

Re: Letter from Dane E. Ericksen of Hammett & Edison, Inc. dated February 20, 1992 regarding the proposed IEEE C95.1-1990 Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

Dear Ms. Gargiulo:

Your letter dated March 4, 1992 to Mr. Ronald C. Petersen has been forwarded to me for response. It is interesting that Mr. Ericksen suggests that the safety guidelines should have been set only in terms of ambient electric (E) and magnetic (H) fields without any reference to limits on body and contact currents. If such were the case the E field limits for lower frequencies 3 kHz to 100 MHz [Tables 1 and 2] would have to be much lower than they presently are since it has been documented by many researchers [1-6] that currents on the order of 630 to 800 mA could be induced in the human body if these E fields were vertical and were in the frequency range 3 - 40 MHz [see e.g. refs 2-4]. Such large RF currents have been shown to produce intolerably high and hazardous temperature elevations in parts of the body most notably the bony sections of the hands and the ankles [5,7].

In view of the published data on the induced currents, the subcommittee 4 of IEEE Standards Coordinating Committee (SCC) 28 grappled with the issue of whether to reduce the E fields at the lower frequencies 3 kHz to 100 MHz. The subcommittee felt that since the E-fields may not always be vertical, adequate protection could be ensured by proposing limits on the induced and contact RF currents. These currents are to be measured for an adult of average height and weight for worst case exposure that may occur in the RF electromagnetic fields.

Ms. Linda A. Gargiulo
March 18, 1992
Page two


It has been shown that socks and shoes (even rubber sole shoes) offer little protection at RF frequencies because of substantial capacitance of the feet to ground. Currents on the order of 63 - 85 percent of the bare foot values have been measured for rubber sole "electrical safety" shoes [4] and even larger induced currents would result if leather sole or thinner sole shoes were used. From published literature [2, 4] it is known that the body induced current at any of the VLF, LF and HF frequencies is proportional to the square of the height of the individual and is consequently smaller for shorter individuals and larger for taller individuals. Since the cross sectional dimensions of the body for "average" individuals are also generally larger for taller individuals than for shorter individuals, the internal current densities and SARs are likely to be quite similar [4]. It is therefore considered sufficient to measure induced and contact RF currents for adults of average height and weight to satisfy the suggested limits on the currents.

It is fortuitous that commercial meters are beginning to appear that obviate the need for human exposure for assessment of the suggested limits on the induced currents. To determine contact current, an impedance equivalent to that of the human body [6] is used. For determination of induced body currents, a human-equivalent "antenna" is used as a surrogate of personnel exposure.

Lastly the point raised in the Erickson letter in regard to the break points for the suggested safety guidelines. Since the safety guidelines are based on science of coupling of electromagnetic fields to humans and the likely biological effects of the coupled energy, the break points were chosen accordingly. The Subcommittee decided not to get involved in proposing safety guidelines by industry or applications.

I would be pleased to answer any other questions that you may have in regard to the rationale for the proposed IEEE C95.1-1990 safety levels.

Sincerely,


OM P. GANDHI
CoChair

cc: R. C. Petersen
E. R. Adair
T. F. Budinger
A. W. Guy
J. M. Osepchuk

OPG:cjp

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REFERENCES

1. K. L. Gronhang and O. Busmundred, "Antenna Effect of the Human Body of EMP," (in Norwegian), Norwegian Defense Res. Establishment, Kjeller, Norway, Rep. FFI/NOTAT-82/3013.
2. O. P. Gandhi, I. Chatterjee, D. Wu and Y.-G. Gu, "Likelihood of High Rates of Energy Deposition in the Human Legs at the ANSI Recommended 3-30-MHz RF Safety Levels," *Proc. IEEE*, 73(6), pp. 1145-1147, 1985.
3. D. A. Hill and J. A. Walsh, "Radio-frequency Current Through the Feet of a Grounded Human," *IEEE Trans. Electromagn. Compat.*, EMC-27, pp. 18-23, 1985.
4. O. P. Gandhi, J. -Y. Chen and A. Riazi, "Currents Induced in a Human Being for Plane-Wave Exposure Conditions 0-50 MHz and for RF Sealers," *IEEE Trans. Biomed. Eng.*, BME-33(8), pp. 757-767, 1986.
5. A. W. Guy, "Measured Body to Ground Current and Thermal Consequences for Human Subjects Exposed to 3.68 MHz and 144.5 MHz," Abstracts of the Ninth Annual Meeting of the Bioelectromagnetics Society, Portland, Oregon, June 21-25, 1987, p. 31.
6. I. Chatterjee, D. Wu and O. P. Gandhi, "Human Body Impedance and Threshold Currents for Perception and Pain for Contact Hazard Analysis in the VLF-MF Band," *IEEE Trans. Biomed. Eng.*, BME-33(5), pp. 486-494, 1986.
7. J. Y. Chen and O. P. Gandhi, "Thermal Implications of High SARs in the Body Extremities at the ANSI recommended VLF-VHF Safety Levels," *IEEE Transactions on Biomedical Engineering*, Vol. BME-35, 1988, pp. 435-441.



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BY FACSIMILE 908-562-1571
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April 17, 1992

Ms. Linda A. Gargiulo
Administrative Assistant
IEEE Standards Department
445 Hoes Lane
Piscataway, New Jersey 08855-1331

Re: Further comments on Proposed BSR/IEEE C95.1-1990 Draft Standard, Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz (proposed revision of ANSI C95.1-1982)

Dear Ms. Gargiulo:

Thank you for your letter of April 6, by which you forwarded a letter dated March 18, 1992, from Dr. Om P. Gandhi, Co-Chair of the IEEE SC-4 Committee. Dr. Gandhi's letter was, in turn, in response to my letter of February 20, 1992, objecting to the proposed adoption of the IEEE C95.1 Standard and urging the American National Standards Institute *not* to adopt it as the successor standard to ANSI C95.1-1982. We appreciate your attentiveness to our concerns; your letter indicated that, if you did not hear from me by April 20, you would assume that my questions had been answered. Please note that they have not, hence this letter and its timely delivery.

Arbitrary and discriminatory 100 MHz cut-off for body current limits

Unfortunately, Dr. Gandhi's letter does not allay our concern that the IEEE C95.1 standard as it currently exists would impose unjustifiable, discriminatory burdens on all VHF low band television broadcast stations (TV Channels 2-6, 54 to 88 MHz) and on approximately half of all FM broadcast stations (88 to 108 MHz). We do not disagree with Dr. Gandhi that significant currents can be induced in the human body by VLF, LF, and HF signals (defined as signals between 3 kHz and 40 MHz, from Dr. Gandhi's letter). Our principal objection to the IEEE C95.1 standard is its extension of a conducted body current specification all the way to 100 MHz--in the middle of the FM broadcast band. We have seen no scientific justification for the selection of 100 MHz as a cut-off point, nor does Dr. Gandhi's letter provide any.

If the IEEE C95.1 standard is left unchanged, one has the nonsensical situation of having a conducted body current limit for a 3-kilowatt Class A FM station at 99.9 MHz, but no limit whatsoever for a 100-kilowatt Class C FM station at 100.1 MHz. We do not understand how the SC-4 Committee can justify ignoring "industry or applications" when

the EPA has found that a class of stations authorized by FCC allocations are significant sources of non-ionizing electromagnetic radiation exposures. Since the cut-off point is arbitrary, selection of 40 MHz (the upper frequency limit mentioned in Dr. Gandhi's letter) is at least as valid. This would then place the added measurement burden only on the two classes of high-powered stations for which we feel the burden is justified: Standard broadcast ("AM") stations and International broadcast ("short-wave") stations. A second advantage to a 40 MHz cutoff is that this would allow a 14 MHz "guard-band" between the top of the conducted current band and TV Channel 2. This, in turn, would allow manufacturers of conducted current sensing devices (such as the Holaday Industries Model HI-3701 Induced Body Current Meter) to add a cost-effective low pass filter, to ensure that the meter does *not* respond to TV or FM signals.

Vague specification of body current limits

Dr. Gandhi's letter states that, for demonstrating compliance with the conducted body current limit, measurements need only be made "for an adult of average height and weight". Unfortunately, there is no such defining language in the IEEE C95.1 standard. Sections 4.1.1(a)(i) and 4.1.2(a)(i) refer broadly to "freestanding individuals". Lacking a revision of this section to match Dr. Gandhi's personal interpretation, it would seem that demonstration of compliance with the IEEE C95.1 standard would have to include body current measurements on, say, a one-meter toddler, a two-meter adult, and all sizes of human beings in between. Even "average height and weight" is vague, as simple tests show differences of several decibels between, for instance, "average" men and "average" woman, as well as between men with relatively minor height and weight differences. Plus, as Dr. Gandhi notes in his letter, there is also several decibels of variation between the conducted body currents measured, for the same individual, with different footwear.

Further, it is unclear whether the IEEE C95.1 standard limits current through one foot or two: Sections 4.1.1(a)(i) and 4.1.2(a)(i) specify "as measured through each foot" while Tables 1. Part B and 2. Part B show limits for "through both feet" and for "through each foot". Simple tests show that the current as measured through two feet is not twice that measured through one foot; therefore, measurements that use only a two-foot protocol, seemingly allowed by the Tables, will understate the true exposure conditions and may incorrectly lead to a determination of compliance for an exposure condition that, in fact, does not comply with the IEEE C95.1 standard. It would seem appropriate to delete from the Tables the extraneous listing for a two-foot current limit.

Arbitrary and awkward mid-band breakpoints

In three sections of the IEEE C95.1 standard, there are breakpoints used to define differing limits for stations within the same band but licensed to frequencies on either side of the breakpoints: 1340 kHz (in the AM band) for E-fields in uncontrolled environments, 100 MHz (in the FM band) for H-fields in all environments, and 100 MHz (again) for induced and contact body currents. This will cause many awkward occurrences in actual application, with different exposure limits applying to different stations within the same band and located at the same site.

Ms. Linda A. Gargiulo, page 3
April 17, 1992

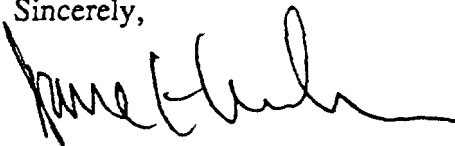
In his letter, Dr. Gandhi alludes to the existence of some scientific justification for these discriminatory and awkward breakpoints. Unfortunately, such justification is found neither in the IEEE C95.1 standard nor in Dr. Gandhi's letter. Obviously, the breakpoints and thresholds selected for use in the IEEE C95.1 standard are just a convenience deriving from the particular metric and logarithmic manner in which scientists and engineers view the spectrum. That should be no reason to hinder the largest classes of intentional emitters of RF energy in their efforts to achieve and maintain compliance with appropriate guidelines.

Lack of consensus

In the absence of any scientific justification, we must remain on record as objecting to the body current limits beyond 40 MHz contained in the IEEE C95.1 standard. Until such time as the sections defining measurement of body currents are amended to define the size of human body to which they apply and to define the body-ground interface conditions for which they apply, we must remain on record as objecting to all of the limits on body currents contained in the IEEE C95.1 standard. Finally, in the absence of any scientific justification, we must remain on record as objecting to the arbitrary specification of transition frequencies for those exposure limits in the IEEE C95.1 standard that are frequency-sensitive.

Thank you for your consideration of this issue. The extensive work that went into the drafting of the IEEE C95.1 standard is obvious, and many of the revisions from the ANSI C95.1-1982 standard are indeed welcome. However, we continue to urge that the IEEE C95.1 standard not be adopted until the serious deficiencies identified above have been addressed and resolved. If additional standards committee activities are planned to work toward the resolution of this issue, please let us know as soon as possible when and where a meeting is to be held, so that we may arrange for one of our engineers to participate.

Sincerely,



Dane E. Ericksen

mk

cc: Dr. Om P. Gandhi, SC-4 Committee Co-Chair
Dr. Robert F. Cleveland, Jr., FCC (w/ copy of Gandhi and Gargiulo letters)
Mr. Jules Cohen, P.E., Jules Cohen & Associates, Inc. (w/ copies)
Mr. Richard A. Tell, Richard Tell Associates, Inc. (w/ copies)

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MICROWAVE AND RADIO SYSTEM ENGINEERS

P.O. BOX 29002 SAN FRANCISCO, CA 94129

COPY

June 18, 1992

Board of Standards Review
American National Standards Institute
11 West 42nd Street
New York, New York 10036

Re: Comments on Proposed BSR/IEEE C95.1 Draft Standard, safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz (revision of ANSI C95.1-1982).

Dear Sirs:

This letter is being submitted in response to the December 27, 1991 ANSI Standards Action newsletter requesting comments from interested parties on various proposed standards. It is our understanding that this Proposed Standard is still within the BSR process.

Our major problem with the standard is its use of arbitrary breakpoints in frequency for changes in exposure limits. The predominant sources of RF radiation are radio and television stations. The literature cited by the Standard does not support the 100 MHz breakpoint for conducted body current. A single research paper does not in our opinion does not suffice for the frequency selected by the standard. Further scientific research should in our opinion be undertaken before setting a breakpoint that will cause what maybe un-necessary financial expense to radio stations. The breakpoint picked is in the middle of the commercial FM band (88 - 108 MHz) why not utilize a frequency of 50 MHz, just above the Private Radio Frequency Band (FCC §90) as a breakpoint. With the breakpoint situated where it is, an FM station operating on an assigned frequency of 99.9 MHz will be treated differently from a station operating on an assigned frequency of 100.1 MHz. The effective radiated power of the stations could vary by a vast amount with the station below the breakpoint at say 3500 watts and the station above the breakpoint operating at 100,000 watts.

As members of ANSI we are concerned that this standard will be adopted by the FCC to replace the ANSI C95.1-1982 standard presently utilized for RFR criteria, with out adequate scientific proof of the 100 MHz breakpoint for conducted body current measurements. We do not think that the adoption of the Draft Standard is in the best interests of ANSI the Standards Community or the Broadcasters of this Country.

Sincerely,

C.S.I. TELECOMMUNICATIONS

A handwritten signature in dark ink, appearing to read "DKS: for Michael S. Newman". The signature is fluid and cursive, with a long horizontal line extending to the right.

Michael S. Newman
Vice President, Engineering

DKS:MSN/cl

CC: Mr. A Lai ESCA
Mr. D.K. Shaffer, P.E. CSI Telecommunications

TEL: (415) 751-8845
FAX: (415) 387-7201

EXHIBIT 9B

C.S.I. TELECOMMUNICATIONS

MICROWAVE AND RADIO SYSTEM ENGINEERS

P.O. BOX 29002 SAN FRANCISCO, CA 94129

January 28, 1993

Mr. Dane E. Ericksen, P.E.
Hammett & Edison, Inc.
P.O. Box 280068
San Francisco, CA 94128-0068

Dear Dane:

This letter is to confirm our telephone conversation in regards the lack of response to our letter of June 18, 1992 to ANSI in response to BSR/IEEE C95.1 Draft Standard. As of this date we have not received a reply to our letter. The letter was mailed First Class to ANSI.

Sincerely,

C.S.I. TELECOMMUNICATIONS



Michael S. Newman
Vice President, Engineering

MSN/cl

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August 3, 1992

Dane E. Ericksen
 Hammett & Edison, Inc.
 Box 280068
 San Francisco, CA 94128-0068

Dear Mr. Ericksen:

Enclosed is the SCC28 rebuttal submitted in response to the concerns expressed in your letter of April 17, 1992.

Feel free to contact me at 908/562-3806 should you have any questions.

Very truly yours,

Linda A. Gargiulo

Linda A. Gargiulo "GAR-JU-LIO"
 Administrator, Standards Board

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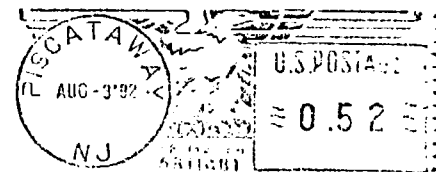
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July 23, 1992

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SC-1

Techniques, Procedures
and Instrumentation
Dr. Howard Bassen
Ctr. Devices & Radiological Health, FDA
(301) 443-3840

SC-2

Terminology and Units
of Measurement
Dr. John M. Osepchuk
Raytheon Company
(617) 860-3041

SC-3

Safety Levels With Respect to
Human Exposure, 0-3 kHz
Dr. John A. Bergeron
G.E. Corp. Research & Development
(518) 387-6350

Mr. William Feero
Electric Research and Management, Inc.
(814) 466-3031

SC-4

Safety Levels With Respect to
Human Exposure, 3kHz-300GHz
Dr. Eleanor R. Adair
J. B. Pierce Foundation Labs
(203) 562-9901; Ext. 218

Dr. Om P. Gandhi
University of Utah
(801) 581-7743

SC-5

Safety Levels
With Respect to Electro-Explosive
Devices

PLEASE REPLY TO:

Dr. Om P. Gandhi
Department of Electrical
Engineering
3280 MEB
University of Utah
Salt Lake City, Utah 84112

not received until
Aug 17

Ms. Linda A. Gargiulo
IEEE Standards Department
445 Hoes Lane
PO Box 1331
Piscataway, NJ 08855-1331

Re: Response to the second letter from Dane E. Erickson of Hammett & Edison, Inc., dated April 17, 1992, regarding IEEE C95.1-1991 "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz"

Dear Ms. Gargiulo:

I am sorry for the delay in responding to the second letter from Mr. Dane E. Erickson objecting to the proposed adoption of the IEEE C95.1 Standard by the American National Standards Institute. My response to all of the questions raised by Mr. Erickson is given in the following:

100 MHz cutoff for body current limits

One of the points made in the letter from Mr. Erickson is that the induced body and contact current limits should be used for the frequency band 3 kHz to 40 MHz, excluding thereby the nonionizing electromagnetic radiation sources such as the TV and FM stations. Mr. Erickson suggests a 40-MHz upper frequency cutoff, presumably on the basis of experimental data given in references 1 and 2, which indeed was for frequencies up to 50 MHz. Further research given in reference 3 has revealed, as expected, that substantial currents are also induced for frequencies in excess of 40 MHz up to 100 MHz and I suspect even at somewhat higher frequencies. Since the current passing through the feet of a standing individual decreases with frequencies higher than about 40 MHz being on the order of 3.2 mA/(V/m) at 100 MHz as opposed to 8.2 mA/(V/m) at 40 MHz [3], Subcommittee 4 of the IEEE Standards Coordinating Committee (SCC) 28 chose the cutoff frequency of 100 MHz. This frequency,

Ms. Linda A. Gargiulo
July 23, 1992
Page two

though picked for convenience, would imply an induced current of nearly 200 mA for the maximum permissible electric field of 61.4 V/m at 100 MHz for controlled environments, and about 90 mA for the maximum permissible electric field of 27.5 V/m for uncontrolled environments. These currents coincide with the limits for the induced currents given in parts B of Tables 1 and 2 of the IEEE C95.1-1991. Since the induced currents do not abruptly end at 100 MHz and the upper FM broadcast frequency of 108 MHz is so close to 100 MHz, a prudent hygienist may want to ensure that the induced and contact currents are indeed less than the proposed limits for all of the FM broadcast sources, even though these limits have not been suggested for frequencies in excess of 100 MHz. In this vein, it is interesting to note that the commercial Induced Body Current Meters are rated for frequencies 3 kHz to 110 MHz, allowing, therefore, the measurement of the induced currents for all of the FM broadcast sources (88 to 108 MHz).

"Vague" specification of body current limits

As mentioned in my previous letter of March 18, 1992, it is well known [1, 2] that body induced current is proportional to the square of the height of the individual and depends also on the posture of the body. Rather than get involved in suggesting current limits for all heights, weights, and postures, the Subcommittee prescribed the induced and contact currents for adults of average height and weight for reasons that were spelled out in my previous letter. From human physiological data, the average height and weight for an adult male is taken to be 1.75 m and 70 kg, respectively. Human equivalent "antennas" that may be used as surrogates of personnel exposure are also becoming commercially available.

A second point raised by Mr. Erickson under this heading pertains to one-foot or two-foot currents. Parts B of Tables 1 and 2 are clear and unambiguous in this regard. Current limits are prescribed through both the feet and through each foot for freestanding individuals. For a standing individual for relatively uniform exposure fields, the current through two feet is twice that for each of the feet. In any case, parts B of Table 1 and 2 prescribe the current limits that should not be exceeded for each of the feet individually and for both of the feet.

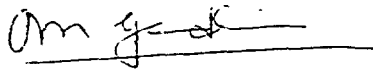
"Arbitrary and awkward" midband breakpoints

I have previously responded to this point by mentioning that the safety guidelines are based on the science of coupling of electromagnetic fields to humans and the likely biological effects of the coupled energy. The Subcommittee defined the breakpoints according to the scientific criteria and not by industries or applications.

Ms. Linda A. Gargiulo
July 23, 1992
Page three

Lastly, as Mr Erickson is aware, refinements of the safety standards is an ongoing process and changes are indeed made as further knowledge warrants these changes. According to the procedures of the IEEE Standards Board, an IEEE standard should either be reaffirmed or revised at least every five years. Right now, the Subcommittee 4 is getting started with the task of going through the next iteration of this standard. This process is carried out by the membership of the Subcommittee in open meetings held twice a year and by mail ballots. If Mr. Erickson or any of his colleagues are interested in participating in the next review cycle for the IEEE C95.1-1991, they should apply for membership on Subcommittee 4 of the IEEE Standards Coordinating Committee 28. My cochair, Dr. Eleanor Adair, and I would welcome their participation in this process.

Sincerely,



OM P. GANDHI
Cochair, SC-4

OPG:jk

cc: E. R. Adair
R. C. Petersen

*what about this
review cycle?*

JUL 31 1992

REFERENCES

1. O. P. Gandhi, I. Chatterjee, D. Wu and Y.-G. Gu, "Likelihood of High Rates of Energy Deposition in the Human Legs at the ANSI Recommended 3-30-MHz RF Safety Levels," *Proc. IEEE*, 73(6), pp. 1145-1147, 1985.
2. O. P. Gandhi, J. -Y. Chen and A. Riazi, "Currents Induced in a Human Being for Plane-Wave Exposure Conditions 0-50 MHz and for RF Sealers," *IEEE Trans. Biomed. Eng.*, BME-33(8), pp. 757-767, 1986.
3. J. Y. Chen and O. P. Gandhi, "RF Currents Induced in an Anatomically Based Model of a Human for Plane-Wave Exposures (20-100 MHz)," *Health Physics*, Vol. 57(1), pp. 89-98, 1989.



HAMMETT & EDISON, INC.
CONSULTING ENGINEERS
RADIO AND TELEVISION

EXHIBIT 11

ROBERT L. HAMMETT, P.E.
EDWARD EDISON, P.E.
Consultants to the Firm

WILLIAM F. HAMMETT, P.E.
HARRISON J. KLEIN, P.E.
DANE E. ERICKSEN, P.E.
GERALD E. SPILLMAN, P.E.
GERHARD J. STRAUB, P.E.
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BY OVERNIGHT DELIVERY

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August 31, 1992

Board of Standards Review
American National Standards Institute
11 West 42nd Street
New York, New York 10036

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File: GE 150				

Passive Letter!

XC IEEE C95.1-1991 done

Dear Board members:

I received on August 17 a copy of the letter dated July 23, 1992, from Dr. Om P. Gandhi to Ms. Linda A. Gargiulo of the IEEE Standards Department, in response to my letter of April 17, 1992, raising several objections to the proposed adoption by ANSI of the IEEE C95.1-1991 Standard without modification. That letter ignores facts in some areas and simply does not respond to the questions I raised earlier, in other areas. This response is being filed within 15 days of receipt of the IEEE letter and reiterates our outstanding concerns about the proposed adoption.

While Dr. Gandhi's opinions¹ may be interesting, he apparently fails to realize that his supplying now additional information *not appearing anywhere in the IEEE Standard* does not make the Standard more precise. Instead, ironically, his need to present one interpretation of the Standard simply demonstrates that the Standard is imprecise. For example, he states in this most recent letter that one should assume "adults of average height and weight" as the measurement criteria for induced body current measurements; I challenge Dr. Gandhi to quote a section from the Standard that leads him to this conclusion. He must realize that any standard has to exist on its own—it must be interpreted by what its specific language says, not what one of its authors thinks it really means, nor what he thinks it should have said.

Even more disturbing is Dr. Gandhi's apparent refusal or inability to consider that people do not move from place to place with both feet always on the ground. I realize that he wishes to divorce his "scientific criteria" from "industries or applications," but he must recognize that people walk! Yes, not surprisingly, "*For a standing individual for relatively uniform exposure fields,*² the current through two feet is twice that for each foot," as Dr. Gandhi states in his letter. But most exposures to high RF fields will occur as people move about in the vicinity of multiple radiating antennas. When dealing with a safety standard, the most correct interpretation, the one that Dr. Gandhi's "prudent hygienist" would use, is the most conservative one. Having only one foot in contact with

¹ Dr. Gandhi is Co-Chairman of Subcommittee 4 of the IEEE Standards Coordinating Committee.

² (Emphasis added.) These words do not appear in the Standard. Note that Dr. Gandhi is interpreting "freestanding individual" to mean a *standing*, not walking, individual, while the text of the IEEE Standard apparently defines that term to mean merely an individual having "no contact with metallic objects."

the ground is obviously the condition of highest current through that foot, and measurements at AM broadcast sites show that this current is much greater than half the current through two feet when both feet are on the ground. The additional "Through both feet" column in Parts B of Tables 1 and 2 introduces a less restrictive measurement condition not appearing in the text of the IEEE Standard. The fact that Dr. Gandhi believes the Standard applies only to a limited measurement condition is further demonstration that this section of the Standard is ambiguously worded.

With regard to Dr. Gandhi's suggestion that we should have participated sooner in this process, I must point out that we wrote to the IEEE Subcommittee *two years ago*, voicing these same objections (please refer to my September 5, 1990, letter to Mr. John J. Woods, then SCC28 Secretary). Hammett & Edison has not been a silent observer; far from it, we have lead the broadcast industry in developing analysis techniques and compliance strategies in the area of RF radiation exposure, and we have initiated FCC proceedings to ensure reasonable applications of the ANSI Standard C95.1-1982. Did the Subcommittee ever consider our objections to the early draft? Since the Subcommittee never saw fit to respond, we do not know. As for Dr. Gandhi's final suggestion that we should simply let this pass into official policy, in order that we might object to it again in five years, I must remind him that the public notice and comment period are designed for exactly this reason, *i.e.*, to allow interested parties the opportunity to raise concerns that the proposing group may have missed. In this case, there are some; ignoring them does not make them go away, nor does ignoring them help those of us who must work under the proposed standards.

In conclusion, our objection to the proposed adoption by ANSI of the IEEE C95.1-1991 Standard in unmodified form continues to rest on the following concerns:

1. The criteria for meeting the induced body current limits are not clear:
 - a) The one-foot and two-feet currents are not related by a factor of two; Parts B of Tables 1 and 2 cannot be correct.
 - b) The current through a foot varies significantly by the material in which it is encased³; the acknowledged lack of specification encourages unreproducible findings and promotes technical disagreement and controversy.
 - c) The current induced in bodies of various size varies significantly; the acknowledged lack of specification encourages unreproducible findings and promotes technical disagreement and controversy.
2. The selection of 100 MHz as the higher frequency limit for body current standards is awkward. On the basis of only one study that measured currents at frequencies above 50 MHz, which apparently showed a drop of 2.5 times⁴ by 100 MHz, the proposed limit is extended without decrease up to 100 MHz, ending arbitrarily in the middle of the largest class of intentional RF radiation sources.

We request, therefore, that any adoption by ANSI of the IEEE C95.1-1991 Standard include 1) specification of precise conditions for measurement of body currents and 2) limitation of body current standards to frequencies no higher than 50 MHz.

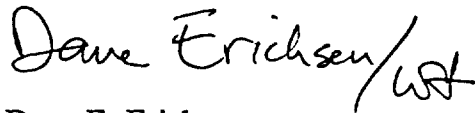
³ Gandhi, Om. Correspondence dated March 18, 1992.

⁴ Gandhi, Om. Correspondence dated July 23, 1992.

ANSI Board of Standards Review, page 3
August 31, 1992

What ANSI does in this matter affects lives and businesses; indeed, that is its mission. Let ANSI then act wisely in insisting on clear standards that reasonable people will apply in consistent fashion.

Sincerely,



Dane E. Ericksen

mk

cc: Ms. Linda A. Gargiulo - BY OVERNIGHT DELIVERY
Dr. Om P. Gandhi
Ms. Eleanor R. Adair
Mr. R. C. Petersen



HAMMETT & EDISON, INC.
CONSULTING ENGINEERS
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EXHIBIT 12

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October 20, 1992

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JT	MK	JM	LR	
File WEISO				

Dr. Om P. Gandhi
SC-4 Subcommittee Co-Chair
IEEE Standards Coordinating Committee 28, Non-Ionizing Radiation
c/o Dept. of Electrical Engineering
3280 MEB
University of Utah
Salt Lake City, Utah 84112

Re: ANSI Adoption of IEEE C95.1-1991, Safety Levels with Respect to Human
Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

Dear Dr. Gandhi:

As a result of a telephone call yesterday to Ms. Beth Summerville of ANSI in New York, I understand that the balloting by ANSI concerning its adoption of IEEE C95.1-1991 as a successor to ANSI C95.1-1982 has been placed "on hold" pending more information on certain aspects of the IEEE C95.1-1991 Standard. Ms. Summerville explained that she was not at liberty to disclose which aspects of the IEEE C95.1-1991 the ANSI voting members were requesting more information on, and she suggested that I contact the standard developer directly.

As you recall, on February 20, 1992, Hammett & Edison formally objected to the proposed ANSI adoption of IEEE C95.1-1991, pursuant to a December 27, 1991, ANSI *Standards Action* notice calling for comments on this Standard on or before February 25, 1992. Perhaps our comments were successful in alerting the ANSI voting members to some of the concerns we have raised about certain aspects of the IEEE Standard.

I understand that the IEEE SCC 28 Committee may be meeting next month in San Diego to consider this development. If you think it appropriate, we will certainly endeavor to attend such a meeting, in order that we may discuss with the Committee how, in our opinion, the Standard might be made more effective.

Dr. Om P. Gandhi, page 2
October 20, 1992

Thank you for your consideration in this matter. I look forward to hearing from you, or a representative of the C95.1-1991 Committee, in the near future.

Sincerely,

Dane E. Ericksen

mk

cc: Ms. Beth Summerville, Program Director, ANSI
Ms. Linda A. Gargiulo, IEEE Standards Department
Mr. James B. Hatfield, P.E., Hatfield & Dawson - BY FACSIMILE 206-789-9834 @ 2:35 p.m.
Mr. Jules Cohen, P.E., Jules Cohen & Associates, P.C.
Mr. Richard A. Tell, Richard Tell Associates, Inc.
Dr. Robert F. Cleveland, Jr., FCC
Mr. Michael C. Rau, NAB
Barry D. Umansky, Esq., NAB
Dr. Louis Slesin, Microwave News
Mr. Michael S. Newman, C.S.I. Telecommunications